

A Rare Papilionid Butterfly *Bhutanitis mansfieldi* (RILEY), Its Rediscovery, New Subspecies and Phylogenetic Position

Toyohi SAIGUSA

Biological Laboratory, College of General Education, Kyushu
University, Ropponmatsu, Fukuoka, 810 Japan

and

Chuan-lung LEE

Zoological Institute, Academia Sinica, 7 Zhongguanchun Lu,
Haitien, Beijing, China

Introduction

Bhutanitis mansfieldi (RILEY, 1939), a rare Papilionid butterfly, was described on a basis of the unique female specimen which was found by M. J. MANSFIELD in a collection of butterflies made by a British botanist, G. FORREST who extensively collected in Yunnan, China. This specimen has no reliable information, but RILEY considered that it almost certainly came from some part of Yunnan. Since then no further material of this rare butterfly has been recorded.

Comparing this species with *Bhutanitis thaidina* (BLANCHARD, 1871), RILEY (1939) stated that although these two species had identical composition of the wing marking and very similar wing venation, *mansfieldi* was very sharply different from *thaidina* in the markedly shorter tails at the hindwing veins 3 and 4, the tail at hindwing vein 2 expanded into a regular lobe, the shorter antenna, the equal (symmetrical) claws, and the distinct narrow transverse white sphragis in the female. He also stated that the sphragis was absent in *Bhutanitis lidderdalii* ATKINSON, 1873 and *thaidina*, and the claws are asymmetrical in both the species.

MUNROE (1960) stated that *B. mansfieldi* was the most primitive in the genus *Bhutanitis*, and that its wing-proportion, maculation and emargination, and the retention of the sphragis were all reminiscent of the genus *Luehdorfia* CRÜGER, 1878. ACKERY (1975) stated that this species showed a curious resemblance to *Luehdorfia* in both the wing markings and shape, and that it was only the *Bhutanitis* species bearing sphragis on the female. Recently HIURA (1980) analysed extensively and precisely wing markings of the Parnassiine genera, and on the basis of some characters of wing markings and venation in addition to the previously detected main differences, he separated *mansfieldi* from the genus *Bhutanitis* and erected a new genus *Yunnanopapilio* to receive it. He considered that *Yunnanopapilio* had the intermediate characters between *Bhutanitis* and *Luehdorfia*, and assumed that such tendency would be found in the male genitalia.

As stated above most authors considered that *B. mansfieldi* had some affinity with *Luehdorfia* and its true taxonomic position would be clarified by the examination of

its male genitalia as this structure is extremely genus-specific in current systems of the Papilionid classification. Thus rediscovery of this species including the male specimens has long been expected by lepidopterists concerning with the Papilionidae.

In spring of 1981, the Hokkaido Alpine Association sent a party to Mt. Gongga in Sichuan, China. Two members of the party, Mr. S. UMESAWA and the late Mr. M. URA who died of a fall over ice-wall in the mountain, quite unexpectedly collected a series of the specimens of both sexes which would be assigned to *B. mansfieldi* near Xinxing (新興) (2,200 m alt.), the foot of the mountain, on 7th of April. These specimens were entrusted to us for a co-operative work between Japanese and Chinese entomologists by the Hokkaido Mountaineering Association through Dr. T. KUMATA of the Entomological Institute of Hokkaido University.

Although these specimens are almost certainly conspecific with the holotype female of *B. mansfieldi*, slight differences can be found in the wing markings and shape between them. So a new subspecies is at first described for the present material in this paper. We also discuss the systematic position of this species based on the morphological characters including the male genitalia.

Materials and Methods

Eleven males and 3 females from Xinxing, Sichuan, China of *B. mansfieldi*, 2 males and 4 females from Kenting, Sichuan, 1 female from Mianning, Sichuan, China, 2 males from Taibaishan, Shanxi, China, 2 males from Dongchuan, Yunnan, and 1 male from Tsekou, Yunnan, China of *B. thaidina*, and 3 males and 3 females from Assam, 3 males from Yingjiang, Yunnan, 1 male and 1 female from Yunlong, Yunnan, China and 2 males and 13 females from northern Thailand of *B. lidderdalii*, all the dried specimens, were examined.

The male and female genitalia were macerated with 15% KOH, and examined under a binocular stereoscopic microscope with magnification up to $\times 80$.

Bhutanitis (Yunnanopapilio) mansfieldi pulchristriata subsp. nov.

♂. Forewing about 2.12–2.27 times as long as wide (the shortest distance between costa and tornus), costa almost straight, termen weakly rounded, most produced outwardly at spaces 5 to 7. Venation similar to that of *thaidina*, common stem of veins 9 and 7+8 usually as long as vein 7+8, but in a few specimens slightly longer than 1/4 of the latter. Hindwing narrow, more strongly stretched towards tornal area than to apex; as space 7 is much wider than in *thaidina*, apex of wing situated at tip of vein 8 (in *thaidina* at vein 7); tail at vein 4 shorter (0.76–0.85 times as long as vein 4 excluding tail), much slender on basal 2/3, strongly spatulate distally, usually more strongly expanded anterodistally than posterodistally; tail¹⁾ at vein 3 shorter (0.31–0.42 times as long as vein 3 excluding tail) and stouter than in *thaidina*, usually slightly dilating apically, weakly curved posteriorly, so that more strongly divergent from tail at vein 4 (two tails almost parallel in *thaidina*); apical area along vein 2 not

¹⁾ Tail is measured from its tip to an intersection of the vein and a line connecting the depths of outer margin of spaces both sides of the vein.

forming a simple tail but produced into a prominent lobe, as space $1b+c$ distinctly emarginate subapically. Venation similar to that of *thaidina*, distance between bases of veins 5 and 6 2.1–7.5 times as long as that between bases of veins 6 and 7; vein 7 almost straight, never convergent to costa of hindwing, ending at subapical part of termen, vein 8 running close to costa, almost parallel with vein 7 and ending at wing apex, so that space 7 parallel-sided beyond origin of vein 7 and much wider than in *thaidina*.

Upperside black with pale yellow stripes on both wings, pink to red postdiscal band, yellow to ochreous submarginal lunules, faint bluish oval markings between the former two markings on hindwing; veins black; fringe yellow, but blackened at tips of veins and around tails or lobe. Forewing marked with a similar yellow bands as in *thaidina*, but differing as follows. 1) Most bands distinctly wider, for instance, middle two bands in discoidal cell $1/5-1/3$ times as wide as black area between them. 2) Anteriorly doubled postdiscal band much reduced, outer branch beyond vein 4 faintly appearing or absent, stem band behind vein 4 represented by scattered yellow scales in space 3 in a few specimens or completely disappearing in most specimens. 3) Submarginal yellow band much wider than in *thaidina*, at each vein its inner margin incised and outer margin sharply produced outwardly along vein. 4) Discal yellow band in spaces 1–2 wider and prominent, suffused with black scales only marginally, strongly produced inwardly along veins 2 and 3, so that its inner margin distinctly emarginate in space 2. Black-centred yellow marking appearing at extreme base of space 2 in a few specimens. Upperside of hindwing similar to that of *thaidina*, but differing in the following respects. 1) Most of yellow markings much more developed as on forewing. 2) Oblique yellow band in discoidal cell wider, shorter, less oblique, and ending posteriorly slightly proximad of origin of vein 2. 3) Veins on yellow area mostly black. 4) Two bands at middle of space 7 much wider, the more basal one of them confluent with similar markings in spaces 5 and 6, and forming an undulate yellow band together; the distal one of them also confluent with those of spaces 5 and 6, and the combined streak almost straight and evenly tapering towards middle of vein 5. 5) Slender bars proximad of submarginal lunules in spaces 5 and 6 often appearing in *thaidina* absent in this species. 6) A faint oval marking formed by scattered yellow scales appearing at subapical portion of space 7 (proximad of submarginal lunule when the lunule is present). 7) Basal $2/5$ of spaces 2–4 yellow, each with an elongate oblong black marking. 8) Postdiscal red band narrower, and in spaces $1b+c$ to 4 the band separated from basal yellow areas by a series of oval or crescent-shaped black markings. 9) Marginal black area in space $1b+c$ much smaller owing to subapical emargination of inner margin of wing, and its faint bluish marking much smaller than those in spaces 2 and 3. 10) Submarginal lunules equally well developed in spaces 3–6, faintly appearing in space 7 in some specimens and in space 2 in one specimen; the lunules ochreous in spaces 2 and 3, yellow in spaces 4 to 7, with a slight ochreous tinge in space 4, and lunule in space 6 close to that in space 5 and almost contiguous.

Underside greyish black with similar but slightly wider yellow markings. Forewing: Anteriorly doubled faint band proximad of submarginal band more prominent than on upperside, a faint streak or a series of faint patches appearing between the distal element of the doubled streak and submarginal stripe in spaces 4 to 8 in some

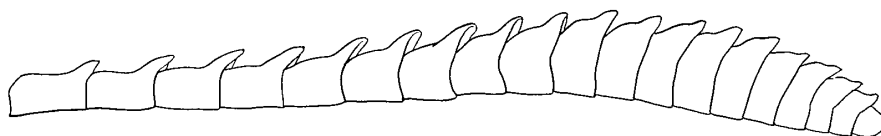


Fig. 1. The 18th to 36th flagellomeres of right male antenna of *Bhutanitis (Yunnano-papilio) mansfieldi pulchriata* subsp. nov.

specimens. Linear yellow stripes running from submarginal band to termen along veins and midline of each space. Hindwing: Discoidal cell with a narrow subbasal band and 3 fine longitudinal streaks along M folds, a transverse bar near origin of vein 2 in space $1b+c$. Submarginal lunules always appearing in spaces 2 and 7; bluish marking at subapical portion of space $1b+c$ always present; submarginal area proximad of submarginal lunules with 2 ill-defined yellow streaks in spaces 4 to 6, one streak in space 7, ill-defined pale marking also appearing between bluish marking and submarginal lunules in spaces 2 and 3. Veins yellowish except for apical $1/3$ of vein 2 and apical $1/2$ of vein 3. Termen narrowly bordered with yellow except apical parts of tails and lobe.

Head black, clothed with long black hairs mixed with yellow ones, posterodorsal portion clothed with yellow hairs. Frons at middle $1/3$ times as wide as head. Compound eye large, rather densely clothed with long fine black hairs (about 0.3 mm long). Antenna black, naked, and gradually thickened apically, on apical $2/3$ of antenna each flagellomere distinctly projecting ventrodorsally, so that flagellum apparently serrate. Labial palpus elongate, directing anterodorsally, its distal $1/2$ projecting forwards beyond the head, densely clothed with long black hairs beneath, its outer side covered with black scales, and on 1st and 2nd segments mixed with some yellow ones; relative lengths of 1st to 3rd segments 3 : 4 : 4. Proboscis black.

Thorax black, black-scaled and densely clothed with long pale yellow hairs. Legs black, femora covered with yellowish scales above towards tip, densely clothed with long yellow hairs beneath mixed with shorter black ones, tibiae with yellow scales on anterior surface mixed with a few black ones.

Abdomen elongate, black and black-scaled, in dried condition apical $1/2$ of abdomen usually strongly curved ventrally; 1st to 7th terga sparsely clothed with fine yellow hairs mixed with a few black ones, lateral margins of terga densely clothed with long yellow hairs on 1st to 4th segments, the hairs shorter posteriorly; 2nd to 7th terga covered with yellow scales on lateral portions of posterior margins; 8th tergum bearing some long stiff black hairs on posterior margin but without dense yellow hairs seen in *lidderdalii*. Abdominal sterna clothed with long yellow hairs mixed with black ones.

Genitalia moderately large, strongly sclerotized and black. Ring rather oblique; tegumen comparatively small, $1/5$ times as deep as whole ring, almost rectangular in dorsal aspect, but gently narrowing apically, $3/5$ times as long as wide, with a dorsomedian suture from a minute invaginated pit at anterior submargin to posterior margin and with a large circular suture which runs from the pit to anterior margin through lateral submargin of tegumen, the former suture with a weak internal ridge, the latter with strongly developed ridge; lateral margin of tegumen weakly emarginate.

Vinculum narrow on upper part, but much broader ventrally, and produced into a long cylindrical saccus 1.2 times as long as height of ring. Uncus extremely long and slender, its basal portion a little narrower than tegumen, separated into a pair of lateral sclerites by a dorsomedian membranization, each uncal sclerite narrowed anteriorly and weakly articulated with posterior margin of tegumen, with a small projection clothed with some long bristles at posterolateral corner and produced into an extremely long, slender process; this paired processes of uncus straight, extending posteriorly beyond tips of valvae, almost parallel with each other, weakly clavate at apices. Valva moderately large, rhomboid, dorsal margin arched beyond the middle, distal surface flattened broadly, apical hook simple, viewed from above evenly tapering to tip; outer wall of valva densely clothed with long setae from middle of costa to posterior surface, but completely free from scales or hair-like scales which are well developed in *thaidina*, inner surface of valva without harpe. Phallus twice as long as height of ring, slender, straight, evenly tapering towards tip, which has a long vesical opening on right ventro-lateral surface. Juxta almost as in *lidderdalii*.

Length of forewing: (36) 40.0–42.5 mm; expanse (61) 67.0–72.0 mm; length of body about 23 mm; length of antennae (14.0) 14.5–17.5 mm (measurements in parentheses are of an unusually small specimen).

♀. Resembling male, and differing as follows. Wing broader; forewing 2.00–2.17 times as long as wide, inner margin longer, termen more evenly and strongly rounded. Tails of hindwing shorter. Upperside ground colour more greyish, yellow makings slightly broader. Head smaller, frons 2/5 times as wide as head, compound eye smaller, but similarly clothed with long hairs as in male. Antenna more weakly serrate. Abdomen stout, pubescence and scales almost as in male, but black hairs dominant on discs of terga and sterna, no stiff long hairs on 8th tergum.

Female genitalia: The 8th abdominal tergum completely fused with its sternum, posterior half of its lateral margins expanding ventrally and almost touching each other at ventromedian line which is represented by more or less membranous groove. Ostium bursae oval, longer than wide, its sides only weakly raised, a distinct keel developed behind the ostium, its edge rather even and straight; ductus bursae long, sclerotized, directing anterodorsally, curved near corpus bursae, which is rounded and membranous, without signum. Papilla analis deeper than long, oval, with a short apophysis posterioris as long as papilla analis, terminal margin of papilla bearing a series of minute spine-like setae. Sphragis (found in all the three females) yellowish white to pale yellowish brown, variable in shape and size, but always representing shape of a mold of apical portion of male genitalia in firmly clasping condition. The largest sphragis as broad as abdomen, as long as 8th sternum, occupying from posterior portion of 7th sternum to anterior 3/4 of 8th sternum; its central portion tightly connected with ostium, but lateral portions detached from sterna partly because the shrunk of the abdomen; a pair of large subventral excavations which undoubtedly surrounded the posterior portions of valvae during copulation, the excavation with a deep hollow directing just behind ostium bursae made by distal hook of valva, the excavated portion containing only a few scattered scales or hairs; two fine, long, thread-like processes arising from central part of sphragis, these processes directing posteroventrally, 1.4 mm long, with a longitudinal groove; anterior part of sphragis glued with many scales and hairs from

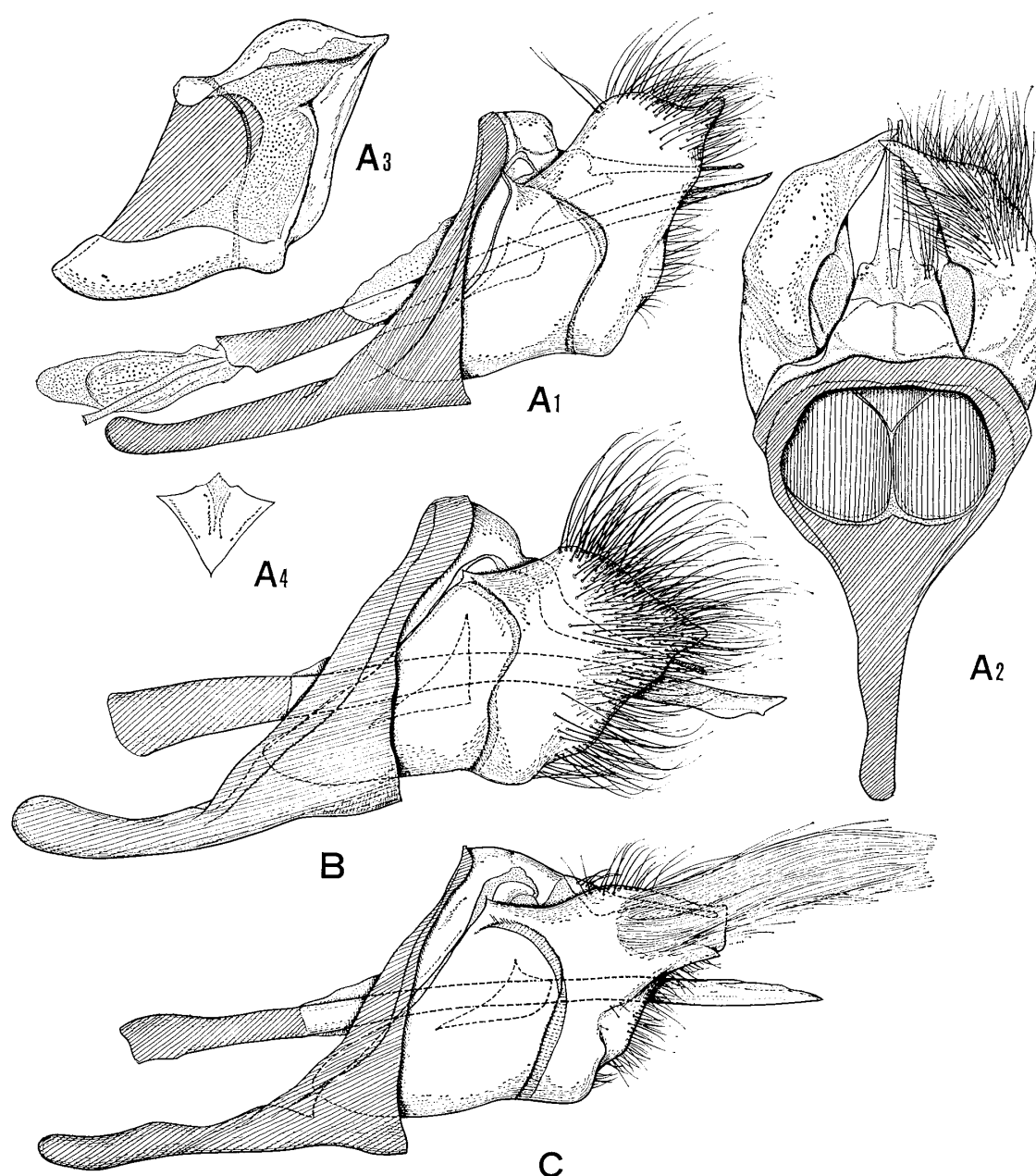


Fig. 2. Male genitalia of *Bhutanitis* species. A1: *B. mansfieldi pulchristriata* subsp. nov., lateral aspect. A2: Ditto (excluding phallus), dorsal aspect. A3: Ditto, valva, inner aspect. A4: Ditto, juxta. B: *B. lidderdalii ocellatomaculata* IGARASHI, lateral aspect. C: *B. thaidina* (BLANCHARD), lateral aspect.

male apical sternum. Sphragis of the second female much smaller than that of the first female, its right portion very small, left one long, and a thread-like process present; anterior margin of sphragis tightly attached 7th sternum. Sphragis of the third female intermediate between the two in size, with some hairs and scales on anterior portion, and with a lateral excavations, but detailed shape is not examined.

Length of forewing: 41.0–43.5 mm; expanse of wing 71.0–73.0 mm; length of body 23.0–24.0 mm; length of antenna 14.0–15.5 mm.

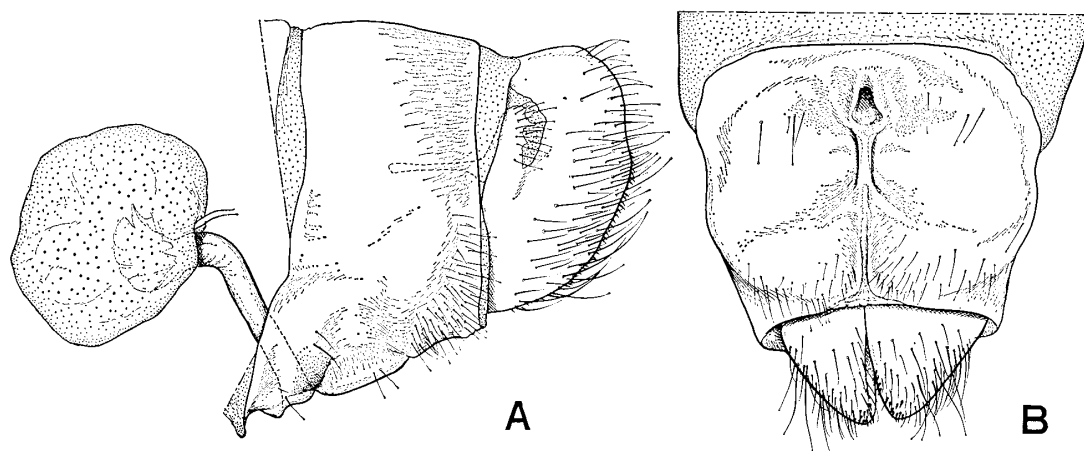


Fig. 3. Female genitalia of *Bhutanitis mansfieldi pulchriata* subsp. nov. A: Lateral aspect. B: Ventral aspect.

Distribution: China (Szechwan).

Holotype ♀, China, Sichuan, Prov. Lutien, Xinxing (新興) (2,200 m), 7. iv. 1981, S. UMESAWA leg. (in the collection of the Institute of Zoology, Academia Sinica, Beijing, China). Paratypes: 11♂♂ 2♀♀, the same data as holotype, collected by S. UMESAWA or M. URA (4♂♂ 1♀ in the Institute of Zoology, Academia Sinica, 3♂♂ 1♀ in the collection of the Entomological Institute, Hokkaido University, Sapporo, 1♂ 1♀ in the collection of the National Science Museum, Tokyo, each 1♂ in the collections of the Osaka Museum of Natural History, Osaka, of the Biological Laboratory, College of General Education, Kyushu University, Fukuoka and of Mr. S. IGARASHI, Tokyo).

Remarks. The females of the present subspecies closely resemble the holotype female of the nominate subspecies, but differing in the following respects (comparison was made by the photographs of the type in the original description). 1) Most of pale yellow stripes or markings on upperside more reduced, for instance, two middle bands in forewing discoidal cell $1/4$ – $1/3$ times as wide as black ground between them ($1/2$ times as wide as in the nominate subspecies), and 3rd yellow band of forewing cell $1b+c$ 0.5 – 0.7 times as wide as its proximal black ground measured along reduced vein $1c$ (about 1.1 times as wide as the black ground in the nominate subspecies). Consequently, black-centred basal marking of forewing cell 3 is separated into subbasal narrow band and basal small spot which has a minute black centre in two specimens; black basal spot appears in the hindwing cell 6. The black longitudinal streaks at the bases of hindwing cells $1c$, 2 and 3 are longer and more strongly extending distally towards the red markings, and the streak also appears in the cell 4. A similar tendency of reduction of pale yellow areas also appears on the underside. 2) Anterior branch of the fine forked longitudinal yellow streak in discoidal cell of hindwing underside ending between anterior $1/3$ and the middle of upper discocellular (ending at base of vein 6 in the nominate subspecies). 3) Tail at hindwing vein 4 longer, $3/4$ times as long as vein 4 excluding the tail, more strongly spatulate distally, especially on antero-distal portion, while in the nominate subspecies the tail $3/5$ times as long as vein 4 excluding the tail and more strongly dilating posterodistally. 4) Tail at hindwing

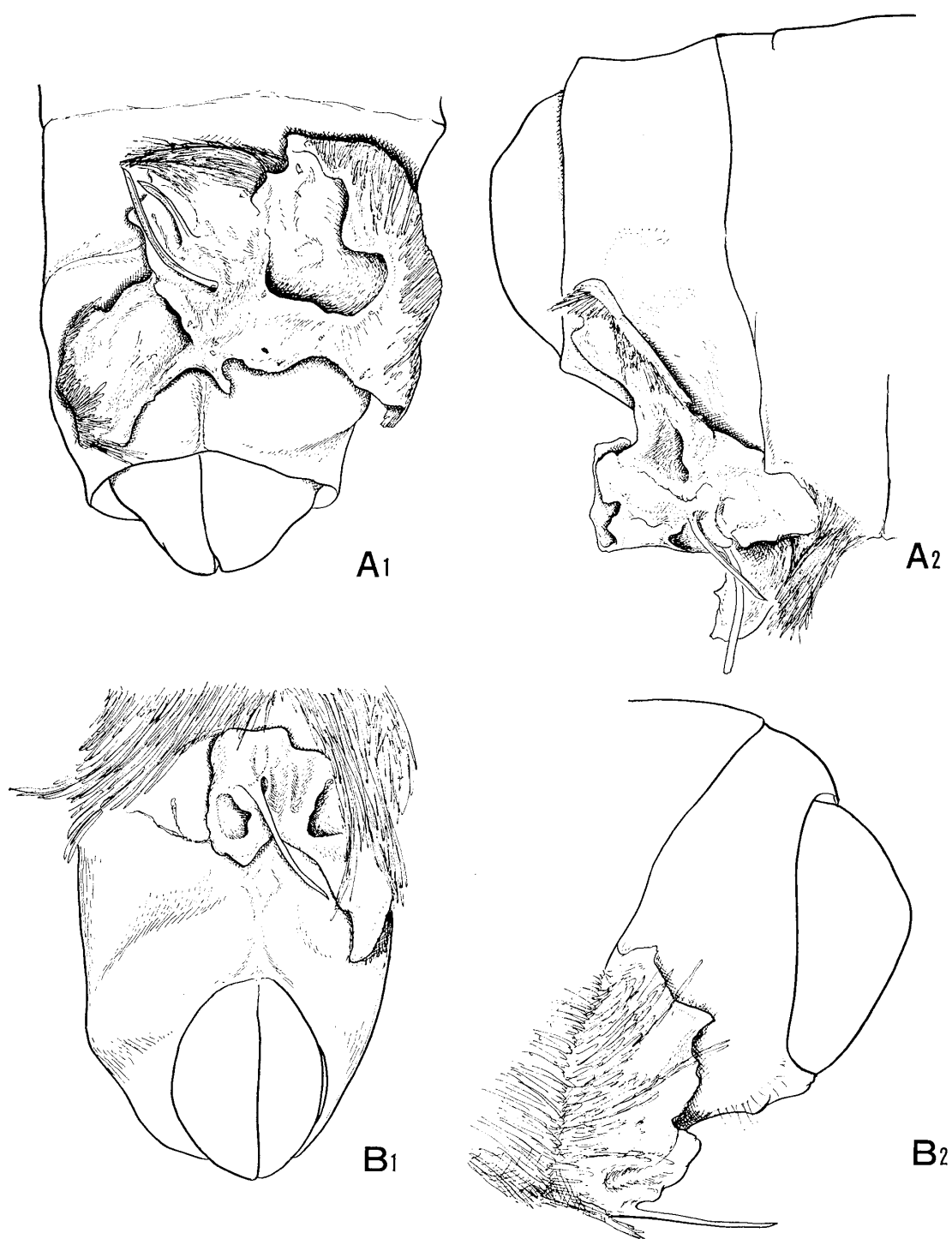


Fig. 4. Sphragises of *Bhutanitis mansfieldi pulchriata* subsp. nov. A1: Female in the collection of Hokkaido University, ventral aspect. A2: Ditto, right lateral aspect. B1: Holotype female in the collection of Academia Sinica, ventral aspect. B2: Ditto, left lateral aspect.

vein 3 longer, $1/3$ times as long as vein 3 excluding the tail, while slightly longer than $1/5$ of vein 3 excluding the tail. 5) Distinct ochreous submarginal lunule of underside of hindwing appears in cell 2 (seemingly absent in the nominate subspecies).

Comparison of Taxonomic Characters

The antennae. A ratio of antennal length to forewing length is 0.39–0.41 in *mansfieldi*, 0.31 in *thaidina*, 0.26–0.27 in *lidderdalii*, and 0.24 in *Bhutanitis ludlowi* GABRIEL, 1942 (from photographs in ACKERY, 1975). The antennae of *mansfieldi* are not so short ('rather shorter') as stated by RILEY (1939), but the longest in comparison with the forewing length among the four species. In *Luehdorfia* the ratio is 0.34–0.35 in *puziloi*, 0.35–0.39 in *japonica*, 0.40 in *chinensis*.

As shown in Fig. 1, the flagellomeres on apical 2/3 of flagellum of *mansfieldi* extremely project at anterodistal corner, and consequently apical thickness (or width) of 20th to 25th flagellomeres in this species roughly 1.5 times of subapical thickness. Thus the flagellum is distinctly serrate, which is unique apomorphic character state even in the entire scope of the Papilionidae. This tendency of flagellomere serration is also observable in *lidderdalii* and *thaidina* and in *Luehdorfia* species in lesser degrees; for instance in *lidderdalii* a ratio of apical thickness to subapical one is up to 1.25; but in these species anterodistal corner of flagellomere is not produced as a distinct projection as seen in *mansfieldi*.

The compound eyes. The compound eyes of butterflies are either naked or hairy in various degrees. The densely long-haired eyes are often observed in many species of the Nymphalidae, Satyridae and Lycaenidae, but the haired eyes even with sparse short pile hitherto have not been recorded in the Papilionidae. As stated in the description of new subspecies, the compound eyes (of both sexes) of *mansfieldi* are clothed with long, fine black hairs nearly 0.3 mm in length. The hairs are not so much dense as in *Nymphalis* or higher Theclines such as *Chrysozephyrus*, but easily recognizable without aid of a microscope or a magnifying glass. The compound eyes of *lidderdalii* and *thaidina* are completely bare as in the species of other Parnassiine genera. The haired condition of *mansfieldi* eyes is undoubtedly an apomorphic character state in the Papilionidae.

The claws. RILEY (1939) described the claws of the holotype of *mansfieldi* to be equal in length. The asymmetrical condition of the claws (anterior claw much longer than posterior one) is universally found in the genera of Zerynthiini. In the present specimens of *mansfieldi*, the claws are distinctly asymmetrical in both sexes. A ratio of the length of posterior claw to that of anterior one is only slightly different by three pairs of legs in one specimen. The ratio in males is 0.69–0.75 in *mansfieldi*, 0.71–0.72 in *lidderdalii*, 0.67–0.70 in *thaidina*; that in females is 0.83–0.84 in *mansfieldi*, 0.77–0.84 in *lidderdalii*, and 0.79–0.83 in *thaidina*. It is clear that the degree of asymmetry of claws is not much varied among species of *Bhutanitis*. It will need to reexamine the claws of the holotype female of *mansfieldi*, which RILEY described to be equal.

The wing markings. HIURA (1980) analysed in detail the wing markings of the Parnassiine genera, and he noticed that *Yunnanopapilio* is mainly different from *Bhutanitis* in the following two respects: 1) the fused condition of 10B, 11B and 12B at the posterior half on the undersurface of forewing, 2) absence of 7B in spaces 4 and 6 on the undersurface of hindwing. This second respect is not found in most specimens of the present material. Thus *mansfieldi* is characterized by the reduction or disappearing of two yellow stripes proximad of submarginal one (13Y of HIURA) on

forewing and the upper surface of hindwing. In this respect *mansfieldi* is similar to *Luehdorfia* species. But the composition of markings on the undersurface of hindwing is quite identical with that in other *Bhutanitis* species. Moreover, the transverse yellow lines running along veins and midline of spaces on the submarginal area on forewing undersurface is one of a few apomorphies in the wing marking of *Bhutanitis*, and this character state is well developed in *mansfieldi*.

The venation. *B. mansfieldi* has broad space 7 of hindwing which retains almost the same width from the origin of vein 7 to the outer margin of the wing. In this respect it is similar to species of *Luehdorfia*, but this condition is an apparent plesiomorphic state, and does not indicate the close phylogenetic relationship between them. In the other species of *Bhutanitis* the vein 7 tends to strongly converge to vein 8, hence the space 7 becomes much narrower apically. It is most pronounced in *lidderdalii*, in which the space is almost linear beyond the middle of vein 7.

The relative positions of the bases of veins 3 to 7 of hindwing are much variable even within one species in *Bhutanitis*. HIURA noticed that the distance between the origins of veins 4 and 5 is much shorter than that of veins 3 and 4. But this condition is not constant in *mansfieldi*.

The precostal cell is well developed and wide in *Bhutanitis*, while in *Luehdorfia* it is very narrow and almost as wide as thickness of anterior vein of the cell (basal section of vein 8). The precostal cell is well developed in *mansfieldi* as in other *Bhutanitis* species.

The wing shape. Among the species of *Bhutanitis*, the wing shape is most specialized in *lidderdalii*. The specialization of wing shape in *mansfieldi* are the following two respects: 1) the spatulation of tail at vein 4, and 2) lobe-like expansion of tail at vein 2. The first respect is unique in the Zerynthiini. The second character is caused by the apical emargination near the tip of vein 1b and the apical expansion along vein 2 of space 1b+c. In *Luehdorfia* the similar condition is observable, but in this genus the apical expansion along vein 2 is rather weak, and the lobe-like appearance is much effected by the development of yellow marginal marking along the depth of the emargination. The subapical emargination of space 1b+c is also found in lesser degrees in *Zerynthia*, *Allancastris*, female of *Sericinus* and many other Papilionid species. It is clear that this character state was attained in many clades in the Papilionidae, and the resemblance of anal area of hindwing between *mansfieldi* and *Luehdorfia* was almost certainly brought through parallel evolution.

The male genitalia. The male genitalia of *lidderdalii* and *thaidina* are characterized by the following respects: 1) dorsum (tegumen+uncus) rather small and weakly developed, 2) a pair of uncal processes which are extremely long, slender, straight, extend posteriorly almost parallel to each other, and end in a blunt (rather clavate) tips, 3) small epicosta (SAIGUSA, 1973) which is distinctly separated from dorsum, 4) large, elongate valva which is strongly sclerotized on outer surface, has a hook-like apical projection and more or less flattened posteroventral surface, but lacks in harpe on inner surface, 5) extremely long aedeagus which is longer than twice height of ring (tegumen+vinculum) and extends posteriorly towards tips of uncal processes and beyond them. Most of these characters except for lengths of uncal processes and aedeagus are very similar to those of *Allancastris*.

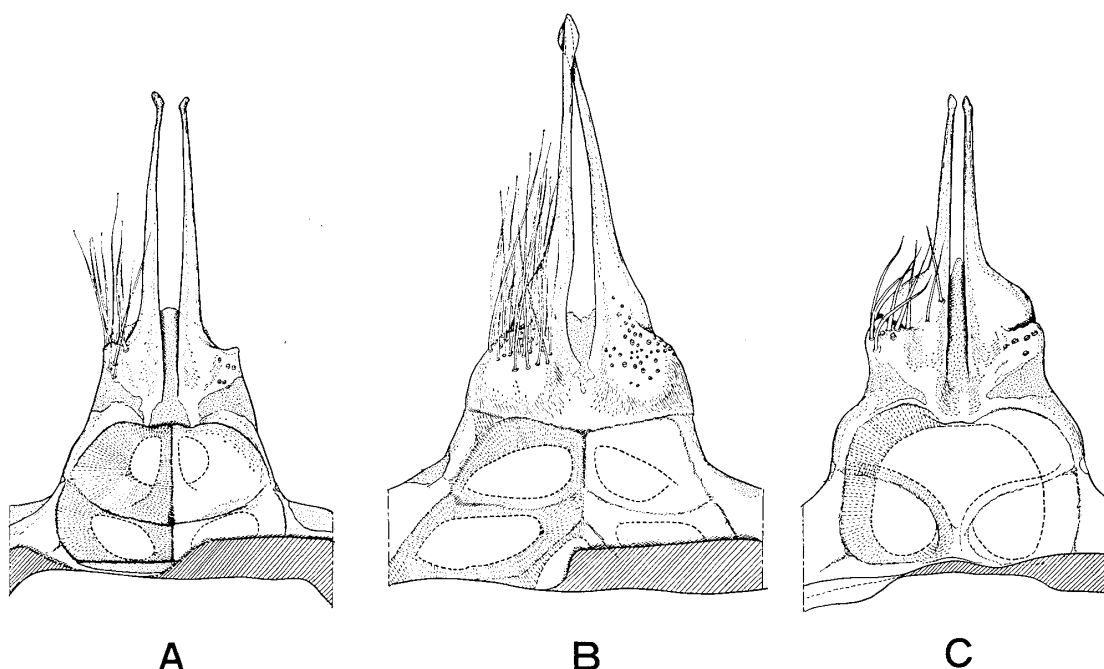


Fig. 5. Dorsa of male genitalia of *Bhutanitis* species, dorsal aspect. A: *B. mansfieldi pulchriata* subsp. nov. B: *B. lidderdalii ocellatamaculata* IGARASHI. C: *B. thaidina* (BLANCHARD).

On the other hand, the male genitalia of *Luehdorfia* are utterly different from those of *Bhutanitis*. In *Luehdorfia* the genitalia are characterized as follows: 1) dorsum is extremely large and strong, 2) a pair of uncus processes is long, but they are thick, curved posteroventrally and sharply hooked at tips, 3) epicosta is extremely large and completely united with dorsum, 4) valva is short and broad, weakly sclerotized on outer surface which bears a dense velvety tuft of short hairs, furnished with membranized harpe and bears densely set strong spines on inner surface of posteroventral portion, 5) short aedeagus 1.5 times as long as height of ring, with its tip not extending to tips of uncus processes.

In the genus *Luehdorfia*, the uncus processes are used to hook a pair of excavations at each side of female ostium bursae, and the valvae have no primary function to clasp the female abdomen but they are used to construct the sphragis for later period of copulation. For these functions, the dorsal region of genitalia is extremely developed and strengthened in this genus, but the valvae are small and rather weakly sclerotized and lack in clasping apparatus. We did not observe the copulation of *Bhutanitis*, but assume that the jointing of male and female genitalia is brought in similar manner in the genus *Allancastris*. In this genus the valvae (especially apical hook) are used to clasp strongly the side of ostium bursae, and the both sexes are jointed only with this structure, while the uncus processes are used as penis guide to direct the tip of aedeagus to the female ostium bursae and they have no function to hook any part of female external genitalia to fasten the both sexes (SAIGUSA, unpublished).

As stated in the description of new subspecies, the male genitalia of *mansfieldi* have every important characteristics of the genus *Bhutanitis*, and do not bear any resemblance to the genus *Luehdorfia* or intermediate condition between the two genera.

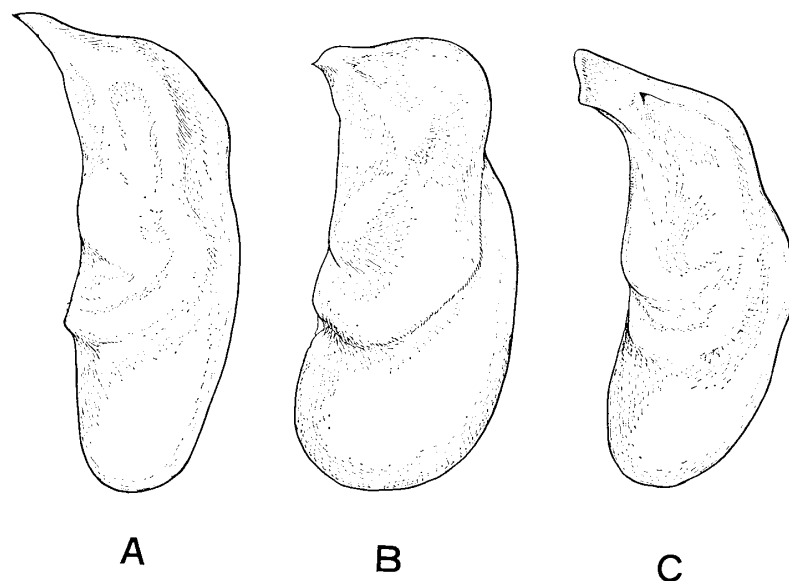


Fig. 6. Right valvae of *Bhutanitis* species, posterovetnral aspect. A: *B. mansfieldi pulchristriata* subsp. nov. B: *B. lidderdalii ocellatomaculata* IGARASHI. C: *B. thaidina* (BLANCHARD).

The followings are the differences of the male genitalia among three species, *mansfieldi*, *lidderdalii* and *thaidina*, which are mostly minor differences in shape not in structural composition.

The tegumen. The tegumen including the sclerotized part of the so-called fenestrula is most strongly convex in *mansfieldi*, and almost flattened in *thaidina*; *lidderdalii* is intermediate in this respect. The internal ridges of this region of *mansfieldi* are fundamentally identical with those of *lidderdalii*, while *thaidina* lacks the dorso-median ridge on the posterior part.

The uncus. The uncal processes are much broad basally in *thaidina* and very slender in *mansfieldi*, and *lidderdalii* is intermediate between them. The basal part of uncus is almost separated bilaterally by the dorsomedian membranization only in *mansfieldi*, but a tendency to desclerotization is seen in the other species.

The valva. The apical portion of valva is much narrowed and ends in a sharply pointed tip in *mansfieldi*. *B. lidderdalii* is similar to *mansfieldi* in this respect but blunter, while in *thaidina* the apical part of valva ends in a truncate narrow lamella with a short spine-like projection arising from subapical portion of the outer wall of valva. The valva bears many bristles or setae on the outer wall in all the species. In addition to these setae, *lidderdalii* sparsely bears long yellow hair-like scales (almost of hair-shape, but easily fall out). In *thaidina* they form a dense long hair-tuft yellow in colour (ACKERY, 1975 described as black). These hair-like scales are attached to the sphragis as stated below. *B. mansfieldi* lacks entirely the hair-like scales and any such scales can not be found on the sphragis in all the females.

The aedeagus. The aedeagus is much slender in *mansfieldi* and thickest in *thaidina*. Its apical portion is sharply pointed in *mansfieldi* and *thaidina*, slightly dilated sub-apically in *lidderdalii*.

From the point of view of overall similarity, the male genitalia of *mansfieldi* and

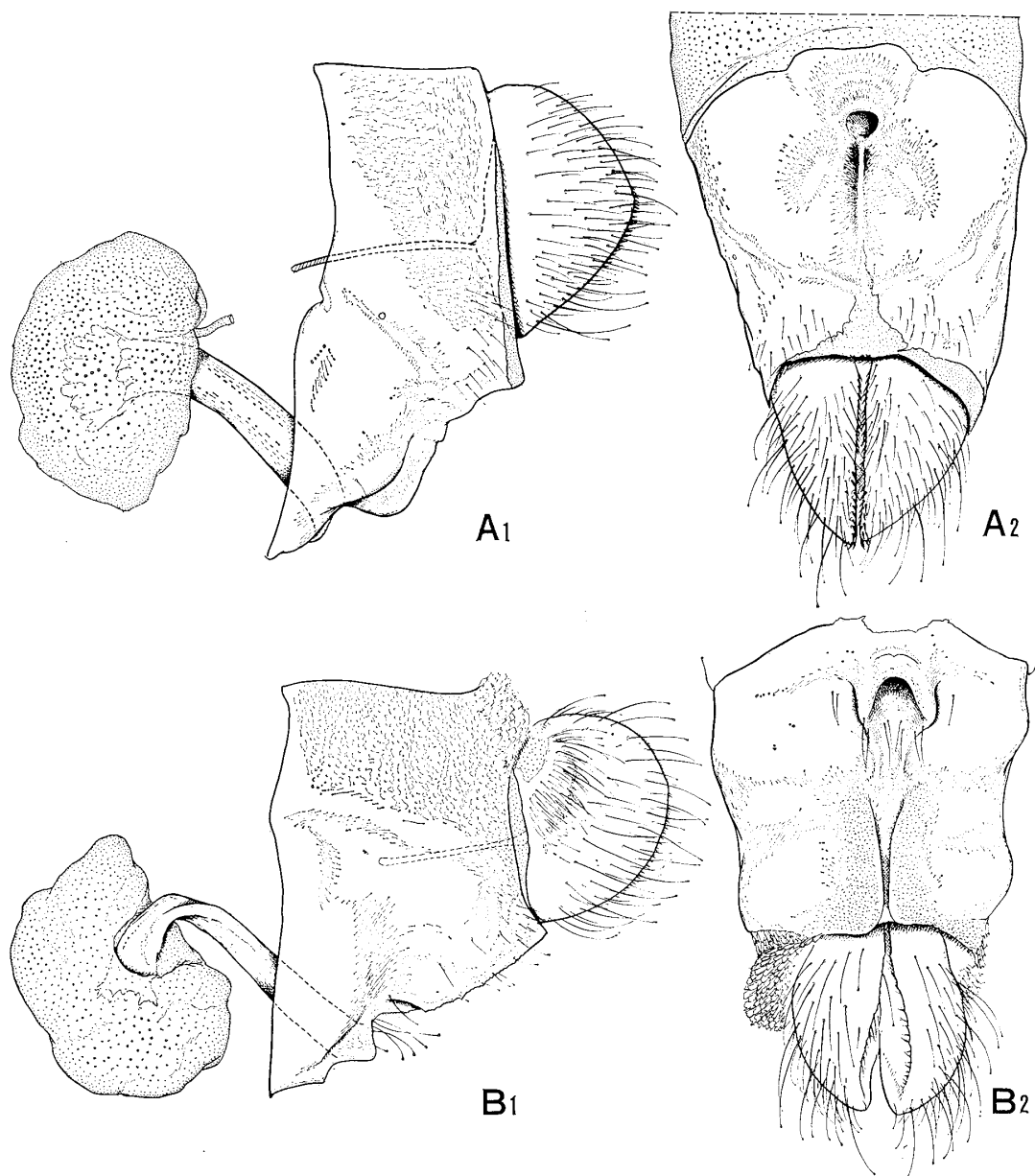


Fig. 7. Female genitalia of *Bhutanitis* species. A1: *B. lidderdalii ocellatamaculata* IGARASHI, lateral aspect. A2: Ditto, ventral aspect. B1: *B. thaidina* (BLANCHARD), lateral aspect. B2: Ditto, ventral aspect.

lidderdalii most resemble each other, but we can not find any strictly synapomorphic characters between these two species in this resemblance. The male genitalia of *thaidina* are specialized in the blunt apical portion of valva and the presence of the hair-tuft on the valva.

The female genitalia. In the plesiomorphic condition of the Zerynthiini, the 8th abdominal tergum is large and bears a pair of apophyses anteriores, and its postero-lateral portions expand posteroventrally reaching to the subventral portion of postero-lateral margin of the 8th abdominal sternum, but two sclerites are distinctly separated by membranous region.

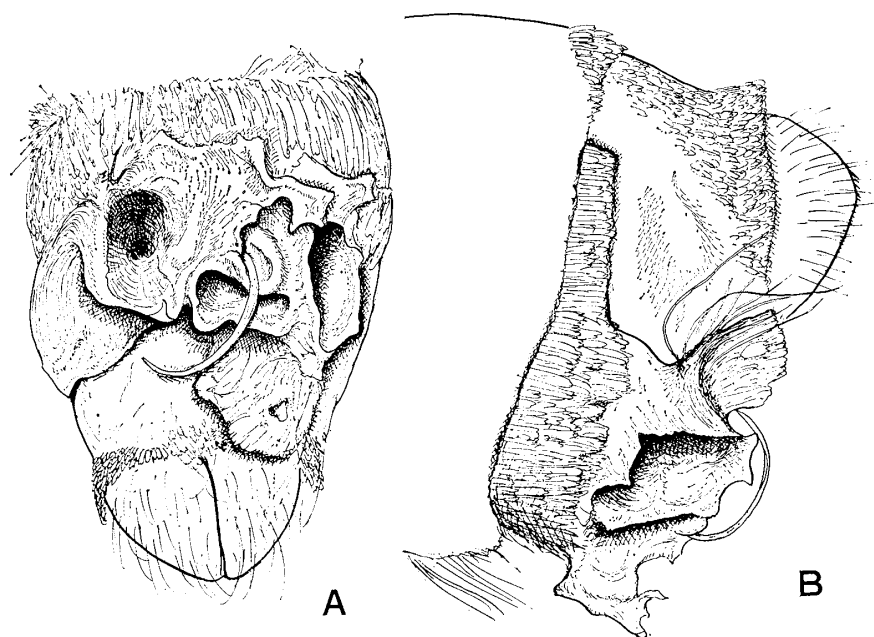


Fig. 8. Sphragis of *Bhutanitis thaidina* (BLANCHARD). A: Ventral aspect. B: Left lateral aspect.

In the genus *Luehdorfia*, the 8th tergum retains the apophyses anteriores and distinction from the 8th sternum, but the tergum is reduced in size and it is divided into a pair of lateral tergites by the dorsomedian membranization. The 8th abdominal sternum of *Luehdorfia* has the ostium bursae close to its anterior margin, and each side of the ostium is excavated to be hooked by the uncus tips of the male genitalia during copulation.

In *Bhutanitis lidderdalii* and *thaidina*, the 8th tergum is large but it is completely fused with the 8th sternum and its posteroventral portion is strongly expanded ventrally behind the sternum and almost reaching to the ventromedian line where the lateral margins of terga are separated from each other only by a very narrow, more or less membranous ventromedian groove.

As stated in the description of new subspecies, the female genitalia of *mansfieldi* are quite identical in fundamental structure with those of the above mentioned two species of *Bhutanitis*, and show no intermediate condition between this genus and *Luehdorfia*.

Among the three examined species of *Bhutanitis*, *mansfieldi* and *lidderdalii* closely resemble each other in the female genitalia as in the case of male genitalia. In the two species the sides of the ostium bursae are almost flattened (in *lidderdalii*) or only slightly raised (in *mansfieldi*), and a distinct ventromedian keel is formed just behind the ostium bursae to be nipped by the tips of the male valvae during copulation. The differences between *mansfieldi* and *lidderdalii* are found in the length of subventral portion of 8th tergum, the shape of the ventromedian keel, the length of apophysis posterioris and the shape of papillae anales. On the other hand, the female genitalia of *thaidina* are different from those of the other two species in the portion to be nipped by the valva tips, and the densely scaled subventral portions of the 8th tergum. In *thaidina* each side of the ostium bursae is much raised, but no ventromedian keel is

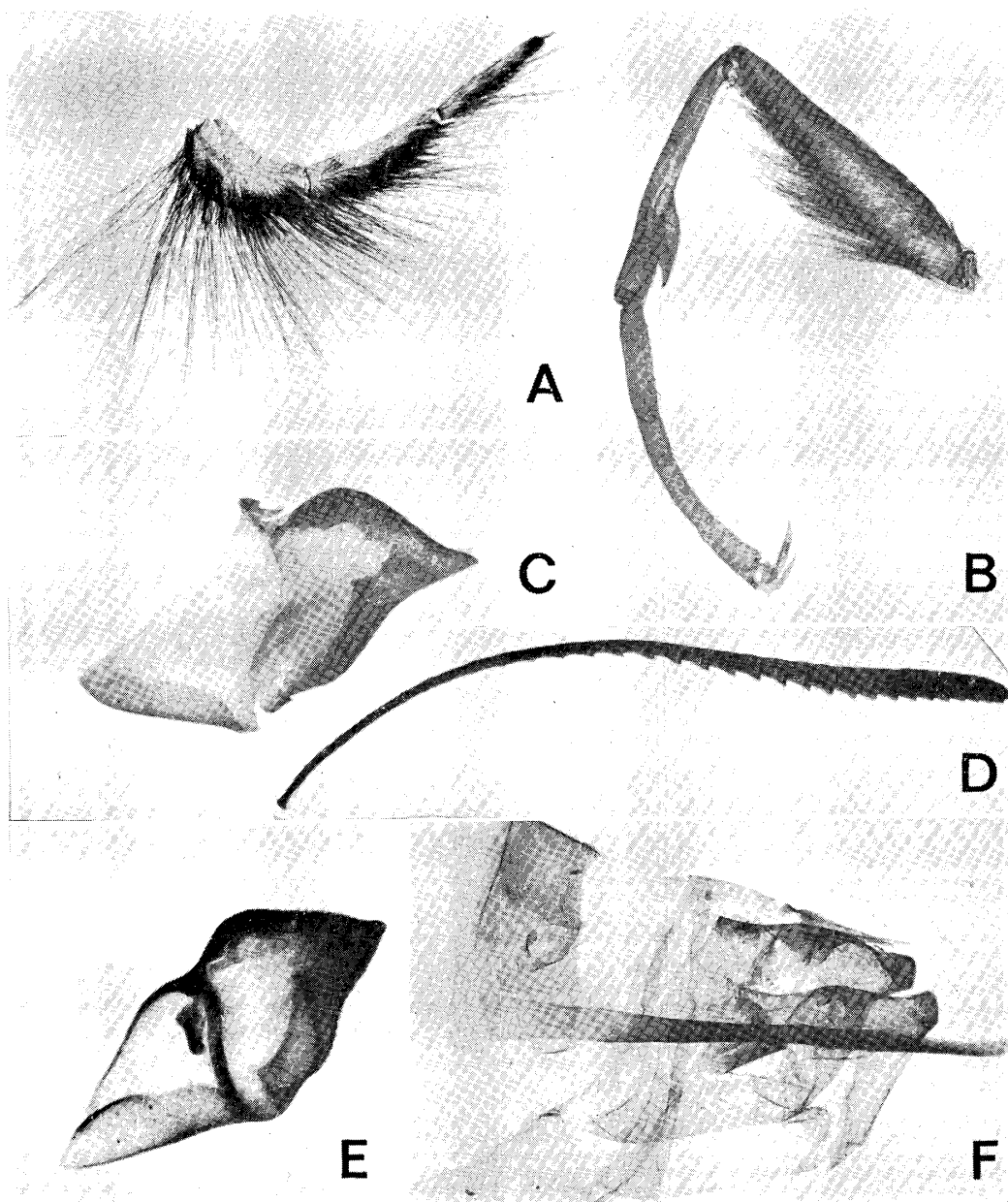


Fig. 9. External structures of *Bhutanitis* species. A: *B. mansfieldi pulchristriata* subsp. nov., labial palpus. B: Ditto, front leg. C: Ditto, right valva of male genitalia, inner aspect. D: Ditto, antenna. E: *Bhutanitis lidderdalii spinosa* (STICHEL, 1907), right valva of male genitalia, inner aspect. F: *B. thaidina* (BLANCHARD), male genitalia, lateral aspect.

formed behind the ostium, but this portion is shallowly grooved. It is almost certain that in this species the tips of valvae nip the bases of the raised sides of the ostium instead of the ventral keel during copulation.

The sphragis. Although RILEY (1939), ACKERY (1975) and HIURA (1980) did not find the sphragis in the female *Bhutanitis* other than *mansfieldi*, it is universally formed on the female genital plate of *lidderdalii* and *thaidina*. All the sixteen examined females of *lidderdalii* have the sphragis and two out of four females of *thaidina* also bear it (the other two females are quite fresh in condition). As the colouration of sphragis in

these species is greyish to brown (except in *lidderdalii* females from Assam which bear yellowish white sphragis) instead of whitish in *mansfieldi*, the previous authors possibly overlooked it. The sphragis of *lidderdalii* from northern Thailand is a grey to dark brown glue-like substance broadly covering the ventral region of the 8th abdominal segment. It has a pair of shallow small excavations near the ventromedian keel behind the ostium, and a long, curved, fine, thread-like projection at the ostium (this projection is usually 2.0 mm in length, gutter-like in shape). The lateral parts of the sphragis often contain more or less glued yellow hair-like scales possibly from the male valvae. The smallest sphragis of this species consists of a plug-like glue-substance confined to the ostium region, and the thread-like projection is present. The sphragis of the same species from Assam is quite similar to that from Thailand, but it is yellowish white in colour.

The sphragis of *thaidina* resembles that of *lidderdalii*. The sphragis of one specimen is greyish brown in colour, and it has a pair of deep excavations which extend to the sides of the ostium (presumably made by the apical parts of valvae), a small midventral hollow (made by aedeagus) from which a long, curved, thread-like projection arises (made by secreted substance remaining in vesica to ductus ejaculatorius), and a small shallow hollow with a pair of small excavations behind the ostium (made by the basal parts of uncal projections). The lateral portions of the sphragis contain many long yellow hair-like scales from the male valvae. An irregularly shaped short projection is also observable in front of the ostium. In another specimen, the sphragis is much larger, covers the entire ventral region of the 8th segment, and has two thread-like projections, one in normal position, another in front of the ostium. Judging from the shape of *Bhutanitis* sphragis it is assumed to be a hardened glue-like substance which is secreted between the tightly jointed male and female genitalia from the male accessory glands of internal genitalia. And it is not an elaborate structure such as *Luehdorfia* sphragis which is constructed by the male valvae used as trowel kneading the male secretion mixing the pile on the outer wall of valvae (TAKAKURA, 1973).

As described in the description of new subspecies, the sphragis of *mansfieldi* is very similar to that of *thaidina*, and does not show any close resemblance to *Luehdorfia* sphragis.

Discussion

1) *The systematic position of mansfieldi*

The phylogenetic relationships among the genera of Zerynthiini are still not clarified soundly. The difficulty arises from the systematic position of *Sericinus* which is much specialized in the larval chaetotaxy, and from the treatment of *Luehdorfia*, of which the male genitalia are quite different from all the other genera in function. So here the discussion is confined to which clade, the *Bhutanitis*-clade or the *Luehdorfia*-clade, does *mansfieldi* belong.

It is clear that each of *Bhutanitis* and *Luehdorfia* represents a distinct monophyletic group. The monophyly of the genus *Bhutanitis* is supported by the following autapomorphies: 1) the presence of a tail at hindwing vein 3 (plesiomorphic in *Luehdorfia*, outer margin of the wing weakly produced at vein 3), 2) precostal cell wide (very narrow

in *Luehdorfia*), 3) the 13 B to 14 B area (of HIURA) of forewing underside with a series of yellow lines connecting the 13 Y band and forewing outer margin (the 13 B and 14 B bands separated from each other by the narrow 14 Y band in *Luehdorfia*), 4) tapering of hindwing space 7 (broad space 7 in *Luehdorfia*), 5) male genital uncus with a pair of long straight processes bluntly ended (with a pair of ventrally curved processes sharply hooked at tip in *Luehdorfia*), 6) male valva produced and strongly sclerotized apically with more or less pointed tip, but without harpe (valva rounded and weakly sclerotized apically, with harpe in *Luehdorfia*), 7) female 8th abdominal tergum completely fused with 8th sternum and lacking apophyses anteriores (separated from the sternum and with apophyses anteriores in *Luehdorfia*). On the other hand, the genus *Luehdorfia* is considered to be monophyletic by reason of the following autapomorphies: 1) fusion of two black bands in basal 1/2 of space 1b+c in hindwing (plesiomorphic in *Bhutanitis*, the basal 1/2 of the space is separated by a yellow cross stripe), 2) fusion of three black bands proximad of submarginal lunules in hindwing (three black bands separated by two yellow bands at least in spaces 4 to 6 in *Bhutanitis*), 3) the absence of subbasal yellow band in discoidal cell of hindwing underside (subbasal yellow band well developed in *Bhutanitis*), 4) subapical emargination of space 1b+c of hindwing strong and tip of vein 2 lobate (weak and tailed at tip of vein 2 in *Bhutanitis*), 5) epicosta of male genitalia united with dorsum (separated from dorsum in *Bhutanitis*), 6) valva shortened (moderately large in *Bhutanitis*), 7) ventrodistal portion of inner wall of valva bearing dense strong spine-like setae (lacking in *Bhutanitis*), 8) apical half of outer wall of male valva membranized and densely clothed with velvety pile (almost bare or with a tuft of long hairs in *Bhutanitis*), 9) female 8th abdominal tergum divided into lateral sclerites by the dorsomedian membranization (8th tergum complete in *Bhutanitis*), 10) sphragis is an elaborate kneaded structure mixed with velvety pile from male valvae.

B. mansfieldi has most of the autapomorphies of the genus *Bhutanitis* except the broad space 7 of the hindwing, but the autapomorphies of the genus *Luehdorfia* found in *mansfieldi* is only the lobe-like expansion of tail at vein 2 in the hindwing and some minor fusion of the black bands of the wings. Thus the resemblance between *mansfieldi* and *Luehdorfia* is detected only in a few character states all well attainable through parallel evolution in the Papilionidae. It is certain that this species was originated from the clade of *Bhutanitis*, not from the *Luehdorfia*-clade.

For the phylogenetic classification it is necessary to clarify the phylogenetic relationships among the four species of the *Bhutanitis*-clade. As we do not examine the detailed structure of the fourth species, *B. ludlowi*, we can not find a sound conclusion. In such small group as the *Bhutanitis*-clade, new data taken from only one species may often change much of the phylogenetic consideration. At present, we can infer the following phylogenetic relationships among the four species based on the above-mentioned available data.

i) The first cleavage between *mansfieldi* and three other species. *B. lidderdalii* and *mansfieldi* much resemble each other in the male and female genitalia, but we can not find any synapomorphic character state in their genitalia. The sharply pointed tips of male valvae seem to be simplest as the clasping organ, and this condition is also found in the allied *Allancastris*. We concluded that this condition is plesiomorphic.

The pointed tip of valva apparently corresponds to the ventromedian keel of the female genital plate found in *mansfieldi* and *lidderdalii*. As we do not examine the musculature of the dorsal region of the male genitalia, we can not comment on the transformation of the internal ridges of this region which differ between *thaidina* and *mansfieldi-lidderdalii*.

Only one distinct synapomorphy enable to assume the first cleavage found in the *Bhutanitis*-clade is the strong convergence of vein 7 towards the vein 8 (or strong tapering of apical half of space 7) which is shared by *lidderdalii*, *ludlowi* and *thaidina*. If *ludlowi* has long hair-like scales on the outer wall of male valvae, the presence of the scales may also be a synapomorphy of them. These two characters are retained as plesiomorphic state in *mansfieldi*. Thus the monophyly of these three species is assumed. This monophyletic group has a sister-group relationship with *mansfieldi* as follows.

B. mansfieldi has two important apomorphies unique to this species in the *Bhutanitis*-clade, i.e. the compound eyes pilose and the hindwing lobate at tip of vein 2. In addition to these two character states, the distally serrate antennal flagellomeres can well be considered as apomorphic, though a tendency to serration is detected in other species. These three character states are all retained as plesiomorphic in three other species.

ii) Relationships in the *lidderdalii*-group. As the genitalia of *ludlowi* are not studied at present, it is difficult to assume soundly the phylogenetic relationships among this species, *lidderdalii* and *thaidina*. *B. lidderdalii* and *ludlowi* seem to form a monophyletic group by reason of a synapomorphy of the much expanded posterodistal area of the hindwing containing the enlarged red marking. *B. thaidina* is apomorphic to *lidderdalii* in the bluntly ended apical portion of the male valva which has a subapical projection and a dense hair-tuft on its outer wall, and in the swellings at each side of the ostium bursae instead of a ventromedian keel on the female 8th abdominal sternum.

In brief, the ancestor of the genus *Bhutanitis* was first divided into the ancestor of *mansfieldi* and the common ancestor of *lidderdalii*, *ludlowi* and *thaidina*, then the latter was differentiated into the ancestor of *thaidina* and the common ancestor of *lidderdalii* and *ludlowi*, which was later differentiated into the two species.

2) *Yunnanopapilio*, a new synonym of *Bhutanitis*

Concerning the phylogenetic relationship of *mansfieldi* to three other species, our conclusion is the same as that of HIURA (1980). But he erected a new genus *Yunnanopapilio* to receive *mansfieldi*. The reason to erect *Yunnanopapilio* is the following characters: 1) the fused condition of 10 B, 11 B and 12 B at the posterior half of the forewing upperside, 2) the lobate apex of the vein 2 of hindwing, 3) parallel condition of the veins 7 and 8, 4) the approaching condition of bases of veins 4 and 5 of hindwing, 5) the symmetrical claws, and 6) the presence of sphragis.

As already stated above, his 4th to 6th characters are now not the strict differences from *Bhutanitis* (sensu HIURA), though the claws of *mansfieldi* holotype are not still examined. The first character of the wing markings is not fundamental, as the variation of wing markings of similar level are often found in the genus *Parnassius*, or in the sexual dimorphism in the genera *Allancastris* and *Sericinus*. The third character, the width of apical half of space 7 (or convergence of the veins 6 and 7) in hindwing,

sharply separates *Yunnanopapilio* from *Bhutanitis*, but phenetically degree of the convergence is variable even in HIURA's *Bhutanitis*; *thaidina* has much wider space 7 than *lidderdalii*. Such differences can be found within the genus *Ornithoptera* though the differences are confined to the male. Moreover, such differences of space caused by convature of veins as found in *Yunnanopapilio* and *Bhutanitis* are not generally considered to be more important than the differences of branching of veins (for instance, radial veins found in the *Parnassius*) or the coalescence of two veins (found in the subgenus *Graphium*). The second difference, the lobate tail at the vein 2, is a distinct character state sharply separate *mansfieldi* from the other species of *Bhutanitis*. But intermediate conditions of the formation of anal lobe are found in the allied genera *Zerynthia*, *Allancastris* and *Sericinus*. It should be noticed that HIURA's aim to erect *Yunnanopapilio* seems to stress (or to expect) the *intermediate* nature of this genus between *Luehdorfia* and *Bhutanitis*. Now it became clear that its "intermediate" nature is found only in the plesiomorphic condition of the hindwing space 7 and in apomorphic anal lobe and wing markings which are attainable through parallel evolution, and that such nature is not found in other structural characters including male and female genitalia.

Thus the very unique apomorphies of *Yunnanopapilio* were detected only in the pilose compound eyes and the serrate antennal flagellomeres. As far as we know, the two character states are not found in any other species of the family Papilionidae. And it is interesting that the two characters seem to have sensory function. As already discussed in detail, both the male and female genitalia of *mansfieldi* are quite identical with those of *lidderdalii* and *thaidina* in main structure, and even most similar to those of *lidderdalii* in shape. Thus how to rank *Yunnanopapilio* is mainly decided by the judgement which character group, two apomorphic differences of the sensory organs or the symplesiomorphic resemblances of the genitalia, we consider important.

The present system of generic classification of the Papilionidae mostly owing to FORD (1944) and MUNROE (1960) is well supported by the morphology of the male genitalia. All the genera of MUNROE's system have the male genitalia markedly different from those of related genera in structural relationship of the main genital components. According to this principle the genera *Zerynthia* (= *Parnalius*) and *Allancastris* are distinct, though both the genera are quite identical in the larval and pupal structures: *Allancastris* has pointed tips of the male valvae which strongly nip the bank-like lateral ridges of a ventromedian furrow behind the ostium bursae, and the female 8th abdominal sternum is densely clothed with fine pile on its posterior half which glues to the sphragis after copulation; *Zerynthia* has broad serrate terminal edges of valvae which presumably clasp the entire female genital plate, which has no dense pile but scales.

To accord the principle attaching importance to the male genitalia, we do not separate *Yunnanopapilio* as a distinct genus from the genus *Bhutanitis*, but treat it as a subgenus of the latter. The followings are our system of *Bhutanitis* classification.

Genus *Bhutanitis* ATKINSON, 1873

- Armandia* BLANCHARD, 1871, C. r. hebd. Seanc. Acad. Sci., Paris, **72**: 809. Type-species: *Armandia thaidina* BLANCHARD, 1871 (by monotypy). Junior homonym of *Armandia* FILIPPI, 1862.
Bhutanitis ATKINSON, 1873, Proc. zool. Soc. Lond., **1873**: 570. Type-species: *Bhutanitis lidderdalii*

ATKINSON, 1873 (by monotypy).

Yunnanopapilio HIURA, 1980, Bull. Osaka Mus. nat. Hist., (33): 71. Type-species: *Armandia mansfieldi* RILEY, 1939 (by original designation). **Syn. nov.**

Subgenus *Bhutanitis* ATKINSON, 1873

The *lidderdalii*-group

1. *Bhutanitis* (*Bhutanitis*) *lidderdalii* ATKINSON, 1873
2. *Bhutanitis* (*Bhutanitis*) *ludlowi* GABRIEL, 1942

The *thaidina*-group

3. *Bhutanitis* (*Bhutanitis*) *thaidina* (BLANCHARD, 1871)

Subgenus *Yunnanopapilio* HIURA, 1980 **Stat. nov.**

4. *Bhutanitis* (*Yunnanopapilio*) *mansfieldi* (RILEY, 1939)

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First of all we wish to express our sincere thanks to Chinese Mountaineering Association and Hokkaido Alpine Association for their kindness in giving us the chance to examine the material of *Bhutanitis mansfieldi*, and also to the late Mr. M. URA and Mr. S. UMESAWA for their rediscovery of this interesting butterfly. We also express our gratitudes to Prof. Chian-ming CHAO, Zoological Institute of Academia Sinica, Dr. T. SHIRÔZU, Fukuoka, Dr. T. KUMATA, Hokkaido University, and Mr. Ming WU, Chinese Mountaineering Association for their kind arrangements for the cooperative work between our countries. Our thanks are also due to Dr. Y. KUROSAWA and Mr. M. OWADA, National Science Museum, Tokyo, Mr. S. IGARASHI, Tokyo, Mr. I. HIURA, Osaka Museum of Natural History for their kindness giving us facilities to study the paratypes of the new subspecies, and Mr. M. NAKAYAMA, Kitakyushu, Dr. K. UEDA, Kitakyushu Museum of Natural History, Kitakyushu and Mr. Y. NISHIYAMA, Tokyo who kindly offer the specimens of *Bhutanitis* species compared with the new subspecies, and Mr. T. SUNOSE, Hokkaido University and Mr. K. KUBO and Mrs. C. ITO, Tokyo for their help in preparing this paper. We also thank again to Mr. M. NAKAYAMA, who kindly presents to the Lepidopterological Society of Japan the colour plate of the new subspecies included in this paper, which was prepared to be published in Chouchou (the Rhopalocerists' Magazine) edited by him.

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摘 要

ウナンシボリアゲハの再発見と新亜種の記載及びその系統的位置について
(三枝豊平・李 伝隆)

ウナンシボリアゲハ *Bhutanitis mansfieldi* (RILEY, 1939) は、中国の雲南地方で採集を行った英国の植物学者、G. FORREST の採集した蝶類標本の中から、M. J. MANSFIELD が見出した 1♀ の標本に基づいて記載された種である。本種は原記載以来全く標本がえられず、しかもこの標本には信頼にたたるデータが全くついていなかった。

本種は *Bhutanitis* 属の他種に比較して、翅形や翅斑が *Luehdorfia* 属と一見類似したところがあり、しかも白く顕著な sphragis (交尾後付属物) をつけているために、MUNROE (1960), ACKERY (1975), 日浦 (1980) は本種と *Luehdorfia* 属との類縁関係に触れており、本種の ♂ の発見に期待していた。特に日浦 (1980) は、斑紋、翅形、翅脈、交尾後付属物、爪等の形態にもとづいて、本種を模式種とする *Yunnanopapilio* 属を創設した。

1981 年春に、北海道山岳連盟は中国四川省の貢嘎山 (ミニヤ・コンガ山) に登山隊を派遣したが、その際同山麓の新興村の近く標高 2,200 m の地点で、隊員の梅沢 俊、故浦 光夫の両氏が全く偶然にも本種を ♂♀ 合わせて 14 頭も採集した。これらの標本は次に述べる亜種的な相違をあらわしているものの、その諸形質は *B. mansfieldi* と完全に一致し、この種と同一種であることはほとんど疑いない。本論文では、これらの標本にもとづいて新亜種の記載を行い、またその形態学的形質を近縁種や *Luehdorfia* 属と比較することによって、本種の分類学的位置について言及する。

Bhutanitis (Yunnanopapilio) mansfieldi pulchriata subsp. nov.

斑紋や翅形の詳細は原色図版で示されているので省略し、従来不明であったいくつかの形態学的特徴について記述する。

複眼は大形で黒色、全面に長さ約 0.3 mm の黒色の細毛を密生する。触角の先方 2/3 では各小節の先端の下面が鋸歯状に突出する。♂ 交尾器：第 8 背板の形状は一般的、その後縁部には長く硬い黒毛をいくらか生ずるが、鱗毛状の軟毛はみられない。♂ 交尾器は比較的大形、tegumen はその周縁部に沿って走る円形の内面隆起線と、これにとり囲まれた十字形の内面隆起線を具える；uncus は基部がほぼ左右に二分され、基部側縁に有毛の小隆起を生じ、著しく細長く、直線状に後方へ伸びる 1 対の uncal process を生ずる；valva は側面からみるとほぼ菱形で、端半部には setae を生じ、内面は広く anellifer となり、遊離骨片または膜状片としての harpe は存在しない；valva 先端部はかなり強く細まり、突起状になる；aedeagus は著しく長く、直線状、先端は鋭く尖る。♀ 交尾器：第 8 背板は腹板と完全にゆ着し、その後半部の側部は下方へ拡大し、両側縁は第 8 腹節の腹中線部ではほぼ相接する；apophysis anterioris を欠く；ostium bursae は第 8 腹板の前縁に近く開口し、その周囲は弱く隆起し、またその後方の腹中線部は顕著な竜骨状突起となる。Sphragis は今回採集された 3 頭の ♀ のい

ずれにも付着しており、色彩は黄白色ないし淡黄褐色。その形状や大きさはやや変異がみられるが、いずれも交尾した状態での♂交尾器の先端部の鑄型の形状をなし、ostium bursaeの両側にあたる位置にはvalvaeの先端部に対応する1対の小孔があり、aedeagus挿入部近くには1~2本の細くやや曲ったフィラメント状のものが突き出している。

前翅長: (♂) 40.0–42.5 mm, (♀) 41.0–43.5 mm. 翅開長: (♂) 67.0–72.0 mm, (♀) 71.0–73.0 mm.

分布: 中国四川省.

完模式標本 ♀, 中国四川省瀘定県新興 (2,200 m), 7. iv. 1981, 梅沢 俊採集 (中国科学院動物研究所蔵). 別模式標本: 11♂♂ 2♀♀, 完模式標本と同一データ, 梅沢 俊または浦 光夫採集 (中国科学院動物研究所, 北海道大学農学部昆虫学教室, 九州大学教養部生物学教室, 国立科学博物館, 大阪市立自然史博物館, 五十嵐邁所蔵).

新亜種 ♀ の原名亜種 ♀ からの相違点. 1) 翅表の黄色条や黄紋は新亜種の方がより減退し, 細くまた小形, 2) 後翅裏面中空の分岐した黄色細条の前枝は新亜種では第 5, 6 脈基部の中央近くで終る (原名亜種では第 6 脈基部で終わる), 3) 後翅第 4 脈の尾状突起は新亜種の方が長く, 尾状突起を除く第 4 脈長の約 3/4, 尾状突起の先端は強くサジ状に拡大する, 4) 第 3 脈の尾状突起も長く, これを除いた第 3 脈長の 1/5 よりやや長い, 5) 後翅表第 2 室にも亜外縁橙色紋があらわれる.

分類形質の比較

本種の分類学的諸形質を *Bhutanitis* 属や *Luehdorfia* 属と比較すると次のようになる.

触角: 鞭節が鋸歯状化する傾向は *B. lidderdalii* シボリアゲハや *B. thaidina* シナシボリアゲハにもいく分認められるが, 本種のように顕著ではない.

複眼: *Bhutanitis* 属の前記 2 種や *Luehdorfia* 属も含めて, アゲハチョウ科では複眼が有毛の種は知られていない. この点で本種は極めて特異な種である.

爪: RILEY (1939) は原記載の中で完模式標本の爪の長さが等しいと記述しているが, 今回の材料では♂♀とも近縁の種や属と同様に爪は明らかに不相称である.

翅斑: 本種は同属の他種と比較して, 前翅や後翅表面の, 亜外縁紋 (日浦の 13Y) より基方の 2 黄条の退行ないし消失がおこり, この点が *Luehdorfia* 属との外観上の類似をもたらしている. しかし, 後翅裏面の斑紋の基本構成が *Bhutanitis* 属の他種と一致していることや, 前翅裏面の亜外縁部にわたって翅脈上に又は翅室中央に沿って走る細黄条が存在することは, 本種の斑紋が *Bhutanitis* 属の斑紋の固有新形質を保有していることを示している.

脈相: 本種の後翅第 7 室は第 7 脈基部から翅の外縁まで幅広く, かつほぼ等しい幅を保っており, この点で *Luehdorfia* 属に似ているが, この類似は旧形質共有に基づく類似で, 両者の強い近縁関係を示す根拠にはならない. 後翅の基室 (precostal cell) は他の *Bhutanitis* 属の種と同様に, 本種でも幅広く, *Luehdorfia* 属の著しく狭い状態とは全く異なっている.

翅形: 本種の後翅外縁の形状は *Bhutanitis* 属の他種に似るが, 第 4 脈の尾状突起の先端がサジ状に拡大する点と, 第 2 脈の尾状突起が第 1b+c 室外縁のえぐれによって葉状突起に変形する点で特異である. 第 2 の特徴は *Luehdorfia* 属と共通するが, 第 2 脈端の葉状化は *Zerynthiini* の他の属のいくつかにも, 程度の差はあっても起っており, 本種と *Luehdorfia* 属の近縁性を強くあらわすものとは考えがたい.

♂ 交尾器: *B. lidderdalii* と *thaidina* の♂交尾器は次の諸点で *Luehdorfia* 属と著しく異なっている. 1) Dorsum (tegumen+uncus) はやや小形で発達が悪い (*Luehdorfia* 属では著しく大形で, 強化されている). 2) 1 対の uncal process は著しく長く, 真直で, 後方に向かって伸長し, 先端は鈍頭に終る (長く, やや下方に曲がり, 先端は鉤状に尖る). 3) Epicosta は小形で, dorsum から分離している (大形で, dorsum と完全にゆ合している). 4) Valva は大形でやや長く, その外壁は強く骨

化し、端半部は裁断されたような平面を形成し、先端は鉤状突起になる。Valva 内壁はいかなる形でも harpe に相当する構造を欠く（短く、幅広く、外壁は端半部の骨化が弱く、ここにピロード状軟毛を密生し、valva の先端には骨化した鉤状突起を欠き、内面には膜状ではあるが harpe に相当する突起が存在する）。*B. mansfieldi* の♂交尾器は上記 5 形質に関してすべて *Bhutanitis* 属の特徴を具有しており、*Luehdorfia* 属との固有の共通性や、同属と *Bhutanitis* 属との中間的形質は全く認められない。

♀生殖器：*B. lidderdalii* と *thaidina* の♀外部生殖器の共通特徴を *Luehdorfia* 属のそれと比較すると次のようになる。1) 第 8 腹節背板は大形で、背中線部で二分されない（*Luehdorfia* 属では小形で、背中線部の膜質化によって左右 1 対の tergites に分断される）。2) 第 8 背板は apophyses anteriores を欠く（有する）。3) 第 8 背板は第 8 腹板と完全にゆ合し、かつその側縁部の後半は下方に拡大し、ほぼ腹中線上に達する（背板と腹板は膜質部で分離され、前者は腹中線部で側縁が接しない）。*B. mansfieldi* の♀外部生殖器はあらゆる点で *lidderdalii* のそれに酷似し、特に ostium bursae の後方に形成される竜骨状突起は両種のみで共通した形質である。

Sphragis: 従来の研究者は *mansfieldi* 以外の *Bhutanitis* 属の種には sphragis が形成されないと記述しているが、筆者らの検した多数の *lidderdalii* や *thaidina* では、一部の新鮮な個体をのぞいて、例外なく sphragis が形成されていた。両種の sphragis は、♂♀の交尾器が結合されている状態で、その間に分泌された粘液が硬化したものと推定され、sphragis 形成後 valvae 先端がはずされた穴が ostium bursae の両側にみられ、また aedeagus 中に残存した粘液が硬化し、aedeagus を抜く時に sphragis について残されたと思われる糸状の突起が ostium 近くから生じている。いずれにしても *Luehdorfia* 属のように valva 外壁のピロード状軟毛を分泌物にねりこんで、valva を用いて種固有の形状にこね上げられた sphragis ではない。*B. mansfieldi* の sphragis は基本的には同属の他の種と全く同一の構造である。

考 察

1. *B. mansfieldi* の系統的位置

Bhutanitis 属と *Luehdorfia* 属はともに Zerynthiini の中の顕著な単系統群である。*Bhutanitis* 属の固有新形質として挙げられるものは次の諸点である。1) 後翅第 3 脈に尾状突起が形成される。2) 後翅の基室が大形である。3) 前翅裏面亜外縁部に翅脈上や翅室中央を走る黄細条があらわれる。4) 後翅第 7 室が先端に向かってその幅を著しく減ずる。5) ♂交尾器の uncal process は細長く、真直で、その先端は鈍頭に終る。6) valva 外面はよく骨化し、先端は尖り、内面には harpe を欠く。7) ♀第 8 背板は腹板と完全にゆ合し、apophysis anterioris を欠く。*B. mansfieldi* はこれらの固有新形質のほとんどすべてを具有し、ただ後翅第 7 室の幅が先端に向かって狭くならない点が一致しないだけである。この点に関しては、本種は *Luehdorfia* 属と一致するが、両者の類似は明らかに旧形質共有に基づいており、近い類縁関係を示すものではない。

一方、*Luehdorfia* 属にも多くの固有新形質があるが、その中で *B. mansfieldi* と一致するものは、後翅肛角部の葉状突起のみである。この形質は、すでに述べた通り、アゲハチョウ科の中で平行的に形成されることが多く、両者の類似は平行現象に基づくものと解釈される。

以上の資料から総合的に判断すると、*B. mansfieldi* は *Bhutanitis* の系統枝に属することは明白であり、*Luehdorfia* の系統枝に含まれないことはもちろんのこと、同属との中間的性格もほとんど具有していない。

Bhutanitis の系統枝に属する 4 種、*mansfieldi*, *lidderdalii*, *ludlowi* ブータンシボリアゲハ、*thaidina* の系統関係については、*mansfieldi* と残りの 3 種の共通祖先種との間で、まず系統分岐が起こったものと推定される。*B. mansfieldi* は触角の鋸歯状化や、複眼の被毛、後翅肛角部の葉状化等の新形質を獲得し、*Bhutanitis* の系統枝の中でも最も孤立した存在である。一方、残りの 3 種は後翅第 7 脈の前

縁部への接近にともなって第7室が著しく狭くなる新形質共有によって、単系統群を構成しているものと推定できる。これら3種の中で、*lidderdalii* と *ludlowi* は赤色紋を含む後翅外半部の後半が強く拡大する点で共通しており、両種が1亜群を形成し、*valva* 先端部の変形やその外壁に顕著な毛束を発達させている *thaidina* と姉妹群関係をもつことが推定される。

2. *Yunnanopapilio* 属の取り扱い

Bhutanitis の系統枝の中での類縁関係については、*B. mansfieldi* と他の3種の間に姉妹群関係が存在するという点で、我々の見解は日浦 (1980) のそれと同一である。しかし、日浦は、1) 前翅表の後半部で 10B, 11B, 12B 等の黒帯がゆ合している状態、2) 後翅第2脈端の葉状突起の存在、3) 後翅第7, 8 脈が平行に走る状態、4) 後翅第4, 5 脈基部が接近する状態、5) 前後で対称的な爪、6) *sphragis* の存在等の根拠によって、*mansfieldi* を他の3種から分離して、新属 *Yunnanopapilio* を創設し、これに所属させた。これらの形質の中で4)~6) の形質は、本論文で *mansfieldi* を *Bhutanitis* から分離する根拠になりえないことが明らかになっている。一方、第1の斑紋の特徴は、例えば *Parnassius* 属内部の種間の変異として認められる性質のものと同じレベルの相違であり、第2の特徴もアゲハチョウ科全体の属の分類の現状から判断すると属を分割するに足る重要性をもつとは考えられない。

結局、*Yunnanopapilio* を分離独立させる根拠としては、本論文で新たに示された有毛の複眼と、鋸歯状の触角鞭節の2形質の検討が残されるだけになる。これら2形質はなるほどアゲハチョウ科としてはかなりユニークなものである。しかし、現行のアゲハチョウ科の属の分類体系は、♂ 交尾器の構造の顕著な相違によって十分支持されたものである。このような分類体系に一致する取り扱いを行うとすれば、♂ 交尾器に他の *Bhutanitis* 属の種と本質的な相違を欠く *mansfieldi* を独立の属として扱うことはできない。すなわち、*Yunnanopapilio* を *Bhutanitis* の synonym として扱い、後者の亜属として残したい。我々の *Bhutanitis* 属の分類体系は英文本文の末尾に示された通りである。

Explanation of Plate 1

Bhutanitis mansfieldi pulchristriata subsp. nov.

A: Paratype, ♂, upperside.

B: Ditto, underside.

C: Holotype, ♀, upperside.

D: Ditto, underside.

E: Paratype, ♂, upperside.

F: Paratype, ♀, upperside.

